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Comparison of Hand-Sewn and Stapled Esophagogastric Anastomosis After Esophageal Resection for Cancer

A Prospective Randomized Controlled Trial

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Objective

The objective of this study was to compare the hand-sewn and stapled methods in esophagogastric anastomosis.

Summary Background Data

After esophageal resection for cancer, the relative merits of the hand-sewn and the stapled methods of esophagogastric anastomosis, especially regarding leakage and stricture rates, have not adequately been studied.

Methods

A prospective randomized controlled trial was undertaken in 122 patients with squamous cell cancer of the thoracic esophagus who underwent a Lewis–Tanner esophagectomy. Patients were stratified according to esophageal size, based on the diameter of the divided esophagus ($< $ or $\geq$ 30 mm) and then were randomized to have either a hand-sewn or a stapled anastomosis.

Results

The mean total operating times (standard error of the mean) when the hand-sewn and the stapled methods were used were 214 (4) minutes and 217 (3.4) minutes, respectively (p = not significant [NS]). The respective *in vivo* proximal resection margins (standard error of the mean) were 8 (0.4) cm and 7.6 (0.4) cm (p = NS). Leakage rates were 1.6% and 4.9% (p = NS). Excluding hospital deaths, patients with leakage or anastomotic recurrence, and those who received radiation therapy to histologically infiltrated resection margin, anastomotic stricture was found in 5 (9.1%) of 55 patients in the hand-sewn group and 20 (40%) of 50 in the stapler group (p = 0.0003). The difference in stricture rates was significant in small as well as large esophagi. Anastomotic recurrence developed in only one patient in each group.

Conclusions

The authors conclude that both methods were safe, but the stapled technique resulted in more stricture formation.

After esophagectomy, the stomach is used most commonly for restoring gastrointestinal continuity. Anastomotic dehiscence is associated with a high mortality rate. When anastomotic stricture develops after a successful esophageal resection, recurrence of dysphagia defeats one of the main aims of surgery, which is to restore normal swallowing function. The esophagogastric anastomosis can be hand-sewn or stapled. Most studies that compared the two techniques were uncontrolled and retrospective. Differences in findings may be caused by heterogeneity in suturing methods, the sites of anastomosis, and ways in which the esophageal substitutes are prepared.[1] Our retrospective studies showed that both techniques were safe, but the stapled method was associated with higher stricture rate.[2,3] This study was not standardized for size of the esophagus. Because of the inherent shortcomings of retrospective studies, we have therefore carried out a prospective randomized trial comparing a single-layer continuous hand-sewn method with the circular stapler in a uniform population undergoing Lewis–Tanner esophagectomy.

METHODS

From November 1989 to June 1995, 122 patients who had squamous cell carcinoma of the thoracic esophagus undergoing a Lewis–Tanner esophagectomy were randomized at surgery after extirpation of the tumor to have an esophagogastric anastomosis constructed by the hand-sewn technique or by a circular stapler. Tumor resection was performed by way of an abdominal and right thoracotomy approach with the whole stomach used as the esophageal substitute. All patients had a pyloric drainage procedure performed, and the anastomosis was constructed at the apex of the right pleural cavity.

After esophageal division, patients were stratified to have a large ($\geq$ 30 mm) or small ($<$30 mm) size esophagus by measuring the outer diameter of the divided esophagus after a Satinsky clamp has been applied. For each size of the esophagus, patients were randomized by the closed-envelope method to have the anastomosis constructed by hand or by stapler. The hand-sewn anastomosis was accomplished using a single layer of continuous absorbable monofilament suture (4–0 Maxon, polyglyconate; Davis and Geck, Danbury, CT). For stapled anastomosis, both the EEA (United States Surgical Corporation, Norwalk, CT) and ILS (Ethicon, Inc, Somerville, NJ) circular staplers were used. We have found that by using the EEA sizer, a stapler size larger than the sizer usually could be accommodated into the esophagus. The size of the stapler was thus selected in the following manner. If the small (25 mm) sizer could not or can just be admitted, a 25-mm stapler was used. If the small sizer could be admitted comfortably but the medium (28 mm) sizer cannot, a 28-mm stapler was used. If the medium sizer could be admitted but the large (31 mm) sizer cannot, a 29-mm stapler was used. If the large sizer could be inserted either sparingly or comfortably, a 31-mm stapler or a 33-mm stapler was chosen, respectively. We selected the largest size stapler that could be inserted safely into the esophagus because of our earlier finding of an increased incidence of anastomotic stricture associated with the smaller size staplers.[2,3] Both the hand-sewn and the stapled methods have been described previously.[4,5]

Perioperative morbidity and mortality, anastomotic leakage and recurrence, and benign stricture rates were the main endpoints of study. At surgery, the operating time, blood loss, and proximal resection margin (defined as the distance from the proximal limit of the tumor and the site of esophageal division *in vivo*) were recorded. After surgery, patients were assessed for anastomotic leakage by a meglumine diatrizoate (gastrografin) contrast study performed on day 7 after surgery. Endoscopy also was done. Anastomotic leakage was diagnosed based on clinical as well as on radiologic evidence. Other complications, including cardiopulmonary morbidity, especially septic complications related to anastomotic leakage, the 30-day mortality, and hospital mortality, were studied.

Patients were observed after discharge every second week for 2 months and monthly thereafter for 1 year, then at 3-monthly intervals. Endoscopic and barium swallow examinations were performed if symptoms of dysphagia returned. Diagnosis of benign anastomotic stricture was made when on endoscopy, a 10-mm diameter flexible endoscope could not be passed. These strictures were dilated under sedation with Savary Gilliard gum elastic bougies (Wilson-Cook Medical Inc.), to a maximal diameter of 15 mm. A malignant stricture was diagnosed on histologic evidence. In the evaluation of benign stricture development, patients who died in hospital, in whom anastomotic leaks developed, or in whom malignant recurrence developed at the anastomosis were excluded. Patients who had tumor-infiltrated resection margin diagnosed on histopathologic examination after surgery and who received postoperative radiation therapy also were excluded.

Statistical differences between groups were determined by the Student's t test, Mann–Whitney *U* test, the chi square test, or Fisher's exact test where appropriate. Survival was calculated with the Life Table method. Differences between groups were compared with the generalized Wilcoxon method. A p value of 0.05 was regarded as significant. All calculations were performed with the

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Table 1. DEMOGRAPHIC DATA OF 122 PATIENTS WHO UNDERWENT A HAND-SEWN OR A STAPLED ESOPHAGOGASTRIC ANASTOMOSIS

	Hand-sewn (n = 61)	Stapler (n = 61)	p
Age (yrs) (mean ± SEM)	64 ± 1.2	63 ± 1.0	NS
Sex (M:F)	54:7	53:8	NS
Level of tumor			
Upper thoracic	0	0	
Middle thoracic	50	49	
Lower thoracic	11	10	NS
Double tumor	0	2	
Stage of tumor			
I	3	2	
II a	9	6	
II b	5	2	NS
III	44	51	
Intent of resection			
Curative	32	31	
Palliative	29	30	NS

NS = not significant.

program Statistical Package for the Social Sciences (SPSS-X version 3.1, SPSS Inc., Chicago, IL).

RESULTS

The demographic data and intent of resection of the 122 patients are listed in Table 1. There were no significant differences in the age, gender distribution, tumor stage, and the intent of the operation between the two groups.

Forty patients in each group had a small size esophagus (p = not significant [NS]). The types of stapler used in the stapler group stratified for size are listed in Table 2.

Table 2. TYPES OF STAPLER USED IN THE STAPLER GROUP STRATIFIED FOR ESOPHAGEAL SIZE

	Esophageal Size	
Stapler Size	**<30 mm**	**≥30 mm**
EEA 25/ILS 25	16	2
EEA 28	24	6
ILS 29	0	4
EEA 31	0	5
ILS 33	0	4
Total	40	21

Values are no. of patients. EEA (United States Surgical Corporation, Norwalk, CT, United States) and ILS (Ethicon Inc., Somerville, NJ, United States).

Table 3. OPERATIVE AND PERIOPERATIVE DATA

	Hand-sewn (n = 61)	Stapler (n = 61)	p
Operating time (min ± SEM)	214 ± 4	217 ± 3.4	NS
Blood loss (mL ± SEM)	721 ± 31	708 ± 33	NS
Length of proximal resection margin in vivo (cm ± SEM)	8.0 ± 0.4	7.6 ± 0.4	NS
Anastomotic leaks (%)	1 (1.6)	3 (4.9)	NS
Pulmonary complication (%)*	6 (9.8)	11 (18)	NS
Cardiac complication (%)†	13 (21)	19 (31)	NS
30-day mortality (%)	0	3 (4.9)	NS
Hospital mortality (%)	4 (6.6)	6 (9.8)	NS

Unless otherwise stated, values are no. of patients (%).
* Pulmonary complications included aspiration pneumonia, bronchopneumonia, respiratory failure, and shock lung.
† Cardiac complications included arrhythmia, myocardial infarction, and cardiac failure. Most were transient atrial arrhythmias.

The duration of operation, blood loss, leakage rates, and postoperative morbidity and mortality rates is listed in Table 3. Anastomotic leakage developed in one patient in the hand-sewn group and three patients in the stapler group. All except one occurred with a small esophagus. In one of these four patients, the leak was subclinical and was shown on contrast study only. This leak was attributed to technical fault because a tear of the posterior wall of the esophagus was made on introducing the stapler. In two other patients, the leaks were minor but required intravenous nutrition and chest tube drainage. Both healed on conservative management. The last patient who had leakage had a hand-sewn anastomosis. The leak resulted in death from empyema thoracis.

Four patients died in the hand-sewn group: three from pneumonia and one from anastomotic leakage. In the stapler group, four patients died of pneumonia and two died of heart failure.

There were 17 patients excluded in the evaluation of benign stricture (4 had anastomotic leakage, 1 of whom also died in hospital; 9 other postoperative deaths; 2 had postoperative radiation therapy to histologically infiltrated resection margin; and 2 had anastomotic recurrence develop). There were, thus, 55 and 50 patients to be evaluated in the hand-sewn and stapled groups, respectively. The mean follow-up time (standard error of the mean) was 20 (2.2) months for the hand-sewn and 19 (2.2) months for the stapled group (p = NS). Data for stricture rates are listed in Table 4. In the hand-sewn group, anastomotic stricture developed in 5 patients (9.1%) compared to 20 patients (40%) in the stapled group (p = 0.0003). The differences in stricture rates when the two techniques

Table 4. INCIDENCE OF BENIGN ANASTOMOTIC STRICTURE WITH REGARD TO ANASTOMOTIC TECHNIQUE AND ESOPHAGEAL SIZE

	Hand-sewn (n = 55)	Stapler (n = 50)	p
<30 mm	4/36 (11%)	14/32 (44%)	0.002*
≥30 mm	1/19 (5.3%)	6/18 (33%)	0.04†
Total	5/55 (9.1%)	20/50 (40%)	0.0003*

Values excluded anastomotic leaks, hospital mortality, radiotherapy to infiltrated proximal resection margin, and anastomotic recurrence. There were no significant differences when the large and small size esophagi were compared when each technique was used.
* Chi square test.
† Fisher's exact test.

were compared were evident in both small and large size esophagi. When the effect of esophageal size was studied with each technique, esophageal size did not result in significantly different stricture rates. Actuarial analyses of the risk of having anastomotic stricture develop with time are shown in Figure 1. Stapler sizes were grouped into large (EEA31/ILS33), medium (EEA28/ILS29), and small (EEA25/ILS25). The hand-sewn method had significantly less chance of having stricture develop compared to that of the medium and small groups ($p = 0.0002$ and $p = 0.01$, respectively).

Regarding the treatment of strictures, in the hand-sewn group, three patients required one dilatation, one required two, and one required three. In the stapler group, ten patients required one dilatation, four required two, two required three, two required four, one required five, and one required seven. The median number of dilatations required for the hand-sewn group was 1 (range, 1–3) and was 1.5 (range, 1–7) for the stapled group. No complications resulted from dilatations.

The median follow-up times to have stricture develop were 3 (range, 1.6–4.4) and 2.8 (range, 0.9–22) months for the hand-sewn and stapled group, respectively (p = NS). There also was no difference in the time to develop stricture when small and large size esophageal groups were compared. The respective median follow-up times were 2.4 (range, 0.9–9.1) months and 3 (range, 1.1–22) months.

The number of patients who had tumor-infiltrated proximal resection margin on histopathologic examination was four (6.6%) in the hand-sewn group and two (3.3%) in the stapler group (p = NS). Four of these patients declined postoperative radiation therapy. None of the six patients had anastomotic recurrence develop. All six patients have died from 8.8 to 40 months after surgery.

Anastomotic recurrence occurred in one patient in each of the hand-sewn and stapler groups. This represented 1.3% of patients who were discharged. The *in situ* proximal resection margins in these two patients were 5 cm and 6 cm, respectively.

At the time of analysis, 37 patients in the hand-sewn group have died, 34 of whom died of tumor-related causes. The respective figures for the stapled group were 43 and 35. The median survival time for the two groups was not significantly different at 14.7 and 12.5 months for the hand-sewn and stapled groups, respectively.

DISCUSSION

Reports comparing the hand-sewn and the stapled methods of esophagogastric anastomosis mostly were uncontrolled in nature. We have shown in this prospective randomized trial that both techniques had low leakage rates in the construction of an intrathoracic esophagogastric anastomosis. Although perioperative morbidity and mortality, long-term anastomotic recurrence, and overall survival rates were the same for both groups, the development of anastomotic stricture was much more prevalent with the stapled method.

Anastomotic dehiscence after esophagectomy is a feared complication after esophagectomy because of its high morbidity and mortality from leakage. The cause of an esophageal anastomotic dehiscence is no doubt multifactorial. Both local tissue and systemic factors are implicated. There also is the inherent properties of the esophagus that supposedly increase the risk of leakage: it has no serosa; the longitudinal muscles hold sutures poorly; and the surgical exposure often is awkward.[1] Surgical technique is thus likely to play a major role.[6,7] The advent of the stapling device has lowered the incidence of leakage and was advocated as the preferred method of anastomosis.[8,9] The result of circular stapler is perhaps more uniform and less operator-dependent; however, with experience, the hand-sewn method is as safe, if not more

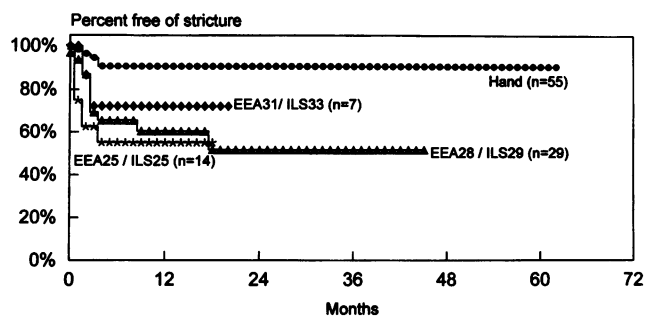

Figure 1. Actuarial analysis of the risk of having stricture develop with the hand-sewn and stapled anastomoses. Hand *vs.* EEA28/ILS29, $p = 0.0002$; hand *vs.* EEA25/ILS25, $p = 0.001$; all other comparisons = not significant.

so, and certainly less expensive. In our retrospective study comparing the two techniques, the leakage rates were equally low with similar mortality, but the stapled method apparently resulted in more stricture formation.[2] This finding is confirmed beyond doubt in the current randomized controlled trial.

A recent prospective randomized study comparing the two techniques indicated that the stapled method resulted in a shorter time required for anastomosis and a faster operating time. Less blood loss also was found with the stapled technique. Stricture rates were similar at approximately 30%.[10] This stricture rate is in the range reported when staplers were used but much higher than that reported for hand anastomosis. In our study, the operating time was not different between the two techniques. The difference in the hand-sewn method may account for some of the differences. The interrupted method was used, although the number of layers was not specified by the authors. A one-layer anastomosis has been shown to produce less stricture compared with that of a two-layer technique,[11] and a continuous method was faster to construct.[12] When a stapler was used, a purse string was placed all around the esophagus, and this was almost equivalent to a continuous one-layer anastomosis.

A fourfold increase in the incidence of anastomotic stricture was found with the stapler group. The anastomotic technique (whether hand-sewn or stapled) had the most significant bearing on stricture, whereas the size of the esophagus was of secondary importance. The highest stricture rate occurred with a small esophagus using the stapler (44%). The reasons why stricture was more common with the stapled method remain speculative, but the lack of accurate mucosa-to-mucosa apposition (with the edges separated by two thicknesses of bowel wall) may play a role because the raw surface heals by second intention with granulation tissue formation. Tissue necrosis beyond the staple line, inflammation, and delayed epithelialization then may predispose to excessive fibrosis and stricture formation. In addition, the unabsorbed circumferentially placed metal staples do not allow the lumen to dilate beyond the size obtained originally. By contrast, the hand-sewn method allows mucosa-to-mucosa apposition. When minimal tension is applied, a continuous single-layer suture offers coaptation with less risk of tissue strangulation than the stapled method or a two-layered hand-sewn technique. Although a nuisance, strictures can be dealt with easily and safely by endoscopic dilatations, with 80% of our patients requiring three or fewer dilatations.

The hand-sewn method was shown in colorectal cancer to be associated with a higher incidence of anastomotic recurrence and cancer-specific deaths.[13] In the current study, with an adequate resection margin, the recurrence rates were low for both techniques. The overall incidence was only 1.3%. We have shown in previous studies that anastomotic recurrence after esophageal resection was a function of resection margin and was uncommon if adequate margin was obtained.[14,15]

To conclude, we have found the one-layer continuous hand-sewn suturing method to be safe and superior to the stapled technique with respect to the development of stricture. It also is less costly. Two sutures cost $3.80 compared to $192.00 for a circular stapler. The benefit of the staplers in their relative ease of application, being less operator-dependent, and similar leakage rates justify their use. For centers with adequate numbers of patients where experience can be gained, the hand-sewn technique is recommended.

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